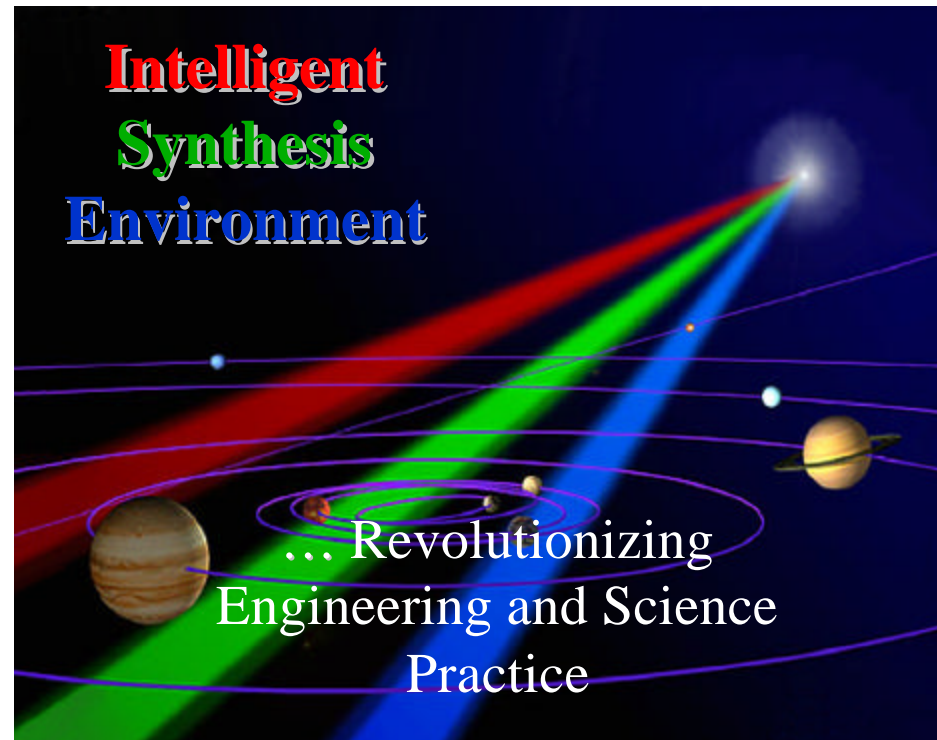




# Intelligent Synthesis Environment

*Intelligent Synthesis Environment Industry/Academia Workshop*

## Overview



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# NASA's Future Mission Challenges

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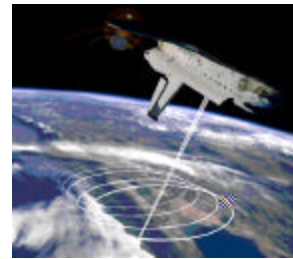
NASA's enterprises envision a myriad of highly complex, first-of-a-kind, missions *which must be developed and executed within reduced budget, workforce and time constraints*



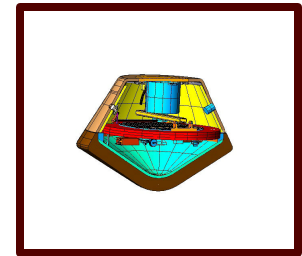
**Single Stage to Orbit Launch Vehicles**



**Shuttle Upgrades/ISS Operations**



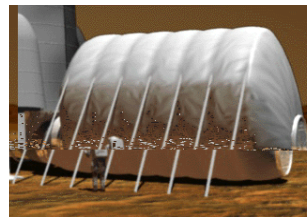
**Earth Science Sensing Fleet**



**Planetary Sample Return**



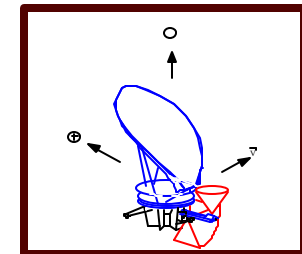
**Advanced Aircraft Concepts**



**Human Exploration**



**Next Generation Astronomy**



**Near-Sun Measurements**



# NASA's Challenges

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- **NASA faces challenging 21 century mission to understand and explore space, understand earth, and advance aeronautics at affordable cost and minimal risk while maximizing science return**
- **To effect a major change in its engineering environment**
  - to maximize utilization of new concepts and technologies,
  - to reduce overall development and life-cycle costs
  - to improve system/mission performance, and
  - to improve risk assessment, failure avoidance and anomaly correction capability
- **To implement its strategic plan to advance and maintain the level of engineering used in NASA's programs **at the cutting edge of, or leading,** the evolving state of the art.**



# Critical Engineering Development Issues\* Must

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### •Category: Design Tools

- Lack of accurate costing and risk prediction methods
- Long model development and simulation time

### •Category: Design process

- Design development cycle remains essentially sequential 10 years after concurrent engineering philosophy adopted by government and industry
- Design and development process steps and their interactions not well understood leading to large design iterations
- Lack of tool integration except at a conceptual design level
- Current design process relies too heavily on testing

### •Category: Insertion of new technology

- Takes many years for new technology to enter practice

### •Category: Design creativity

- Design creativity inhibited by clumsy processes, empirical tools and lack of collaboration
- Little collaboration between scientists, engineers, operations and training personnel

\* Code R sponsored Design Tools Roadmapping Workshop, August 17-19, 1998

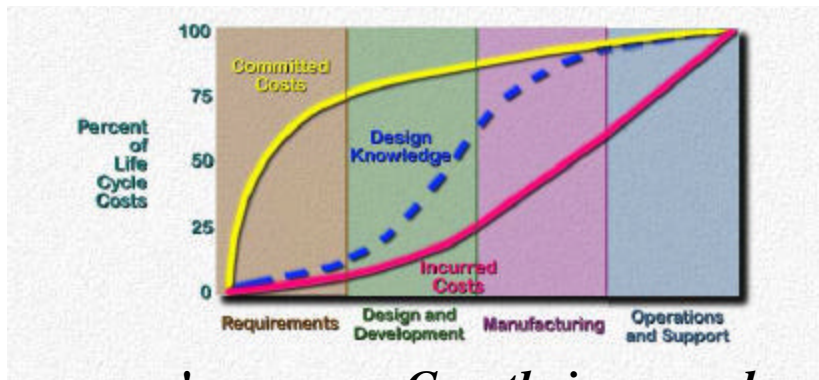


# Product Development Cycle and Costs Must Be Reduced

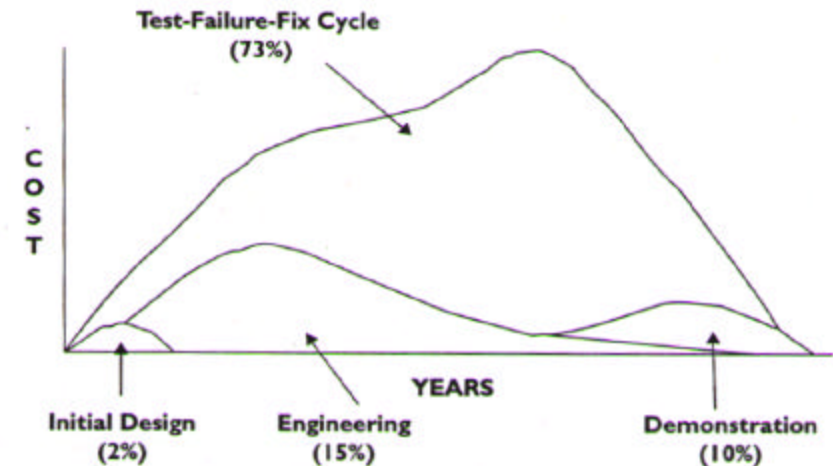
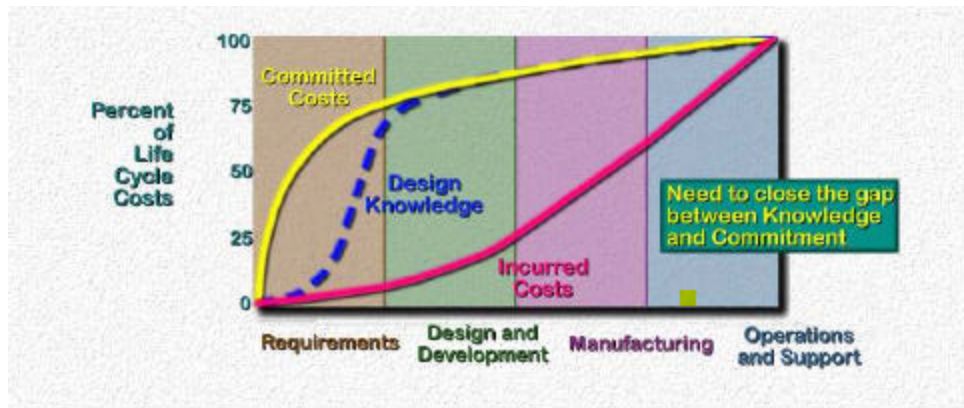
## Intelligent Synthesis Environment Industry/Academia Workshop

**Today's process:** 90% of costs are committed to within the first 10% of the development cycle. Changes are very costly!

**Current Design Process Is Highly Dependent On Ground and Flight Testing**



**Tomorrow's process:** Greatly increased knowledge is needed during design process to eliminate need for late-in-the-cycle design changes



**Example:** Test-Failure-Fix cycle for a commercialized rocket engine using only incremental technology improvements - new technologies even more costly to incorporate. (New car models follow a similar cost profile!)\*

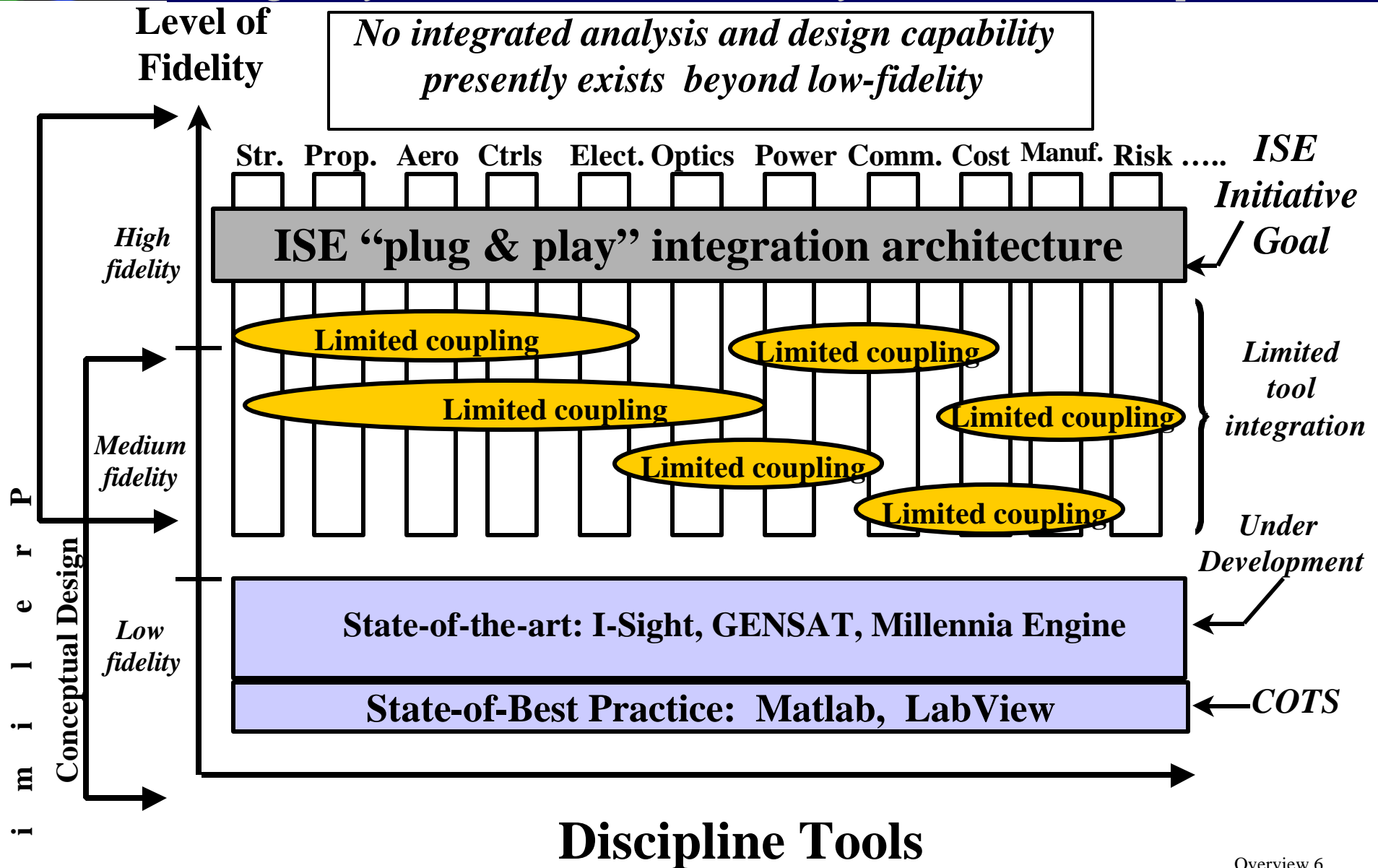
from: Allen & Jarman, Collaborative R&D, Manufacturing's New Tool





# Future Engineers Need A Highly Integrated Analysis and Design Capability

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# Engineering Environments Must Change to Meet Challenges of 21st Century Mission

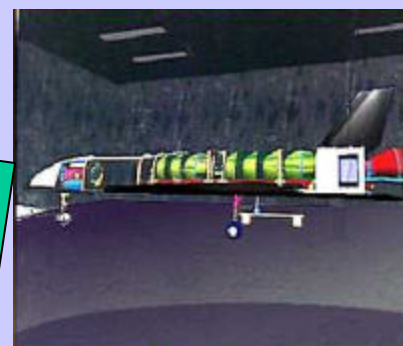
*Intelligent Synthesis Environment Industry/Academia Workshop*



**Digital Life &  
Full Virtual Product**



**Digital Process**



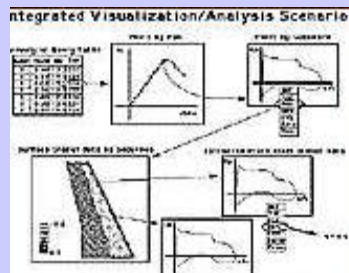
**Digital Mock-up**

**Where we  
Need to be**

**Where we are now**



**Pre-CAD**



**2D Drawings**



**3D CAD**

**Where we've been**



# ISE Vision and Long-Term Goal

*Intelligent Synthesis Environment Industry/Academia Workshop*

## Vision

*To effect a cultural change that integrates into practice widely-distributed science, technology and engineering teams to rapidly create innovative, affordable products*

## Long-Term Goal

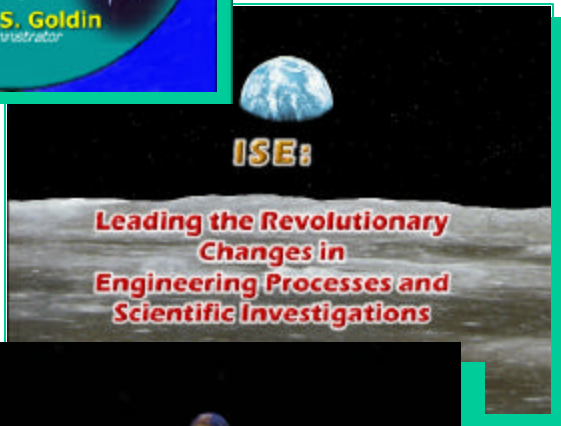
*To develop the capability for personnel at dispersed geographic locations to work together in a virtual environment, using computer simulations to model the complete life-cycle of a product/mission with near real-time response time before*



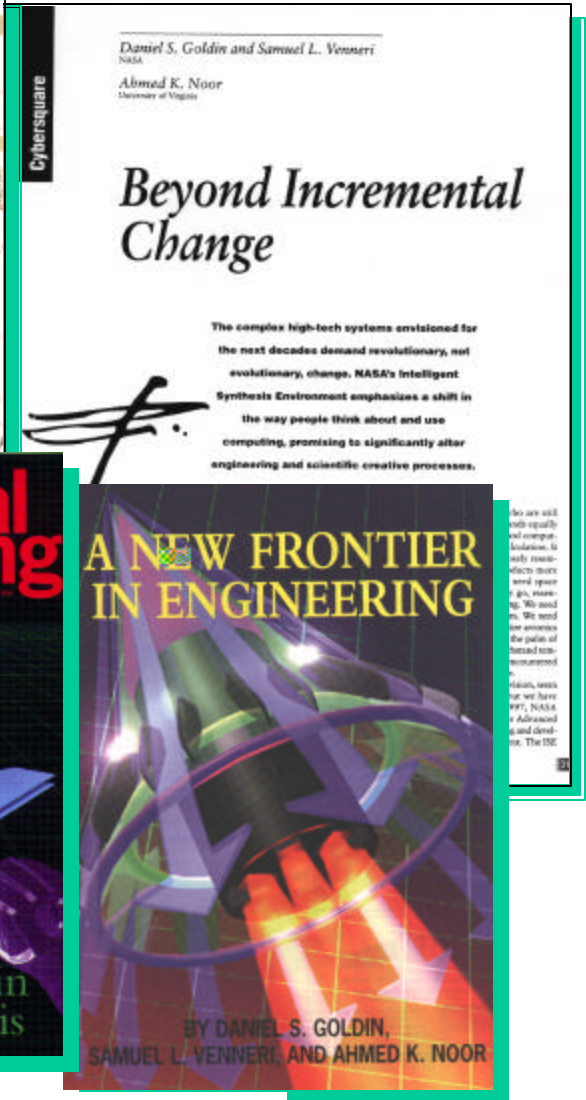


# Administrator's "Pathway to the Future" Vision

## *Intelligent Synthesis Environment Industry/Academia Workshop*



Multi-Media CD-ROMS



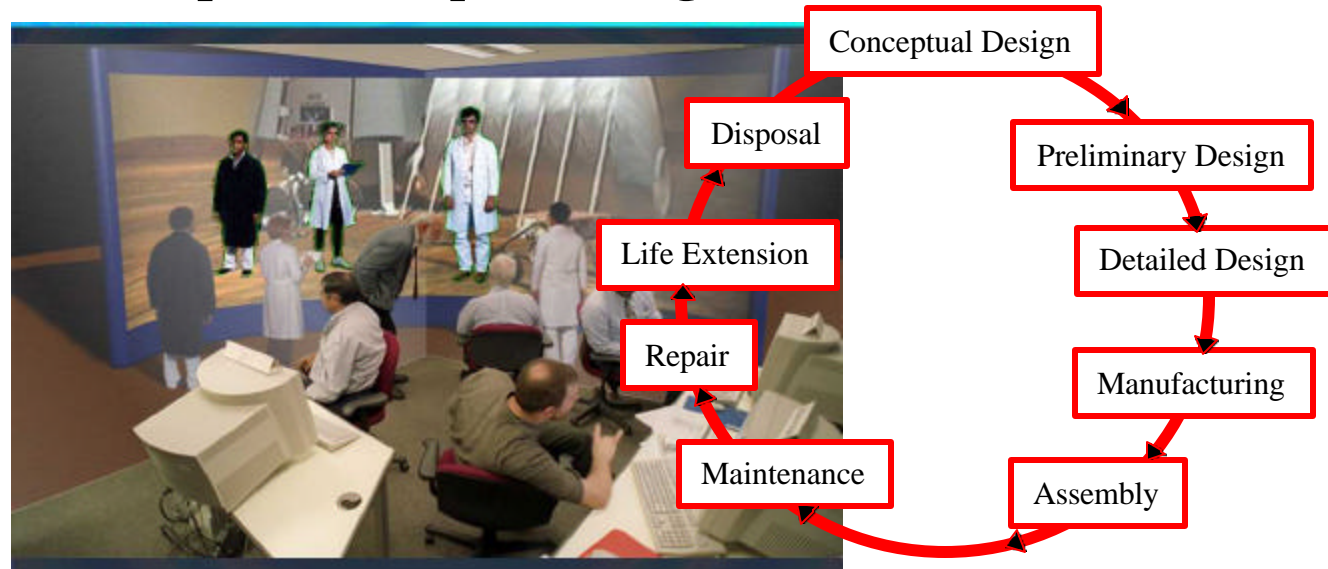
Publications



# A “Holodeck-Like” Design Capability for 21st Century Science and Engineering Teams

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- Engineers/Scientists can experience complete immersion and sensory feedback within the design environment
- Near real-time design changes with resulting impacts to all elements of the product/mission life-cycle
- A true multidisciplinary design environment with instantaneous sharing of data and knowledge between Science and Engineering experts
- Close coupling of Science Mission Requirements and Engineering product/platform solutions prior to acquisition “go-ahead”



**NASA’s Mission Life Cycle Analysis**



# ISE 5-Year Goal

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*To develop the capability for personnel at dispersed geographic locations to work together in a virtual environment, using computer simulations to **rapidly** model the complete life-cycle of a product/mission before commitments are made to produce physical products*

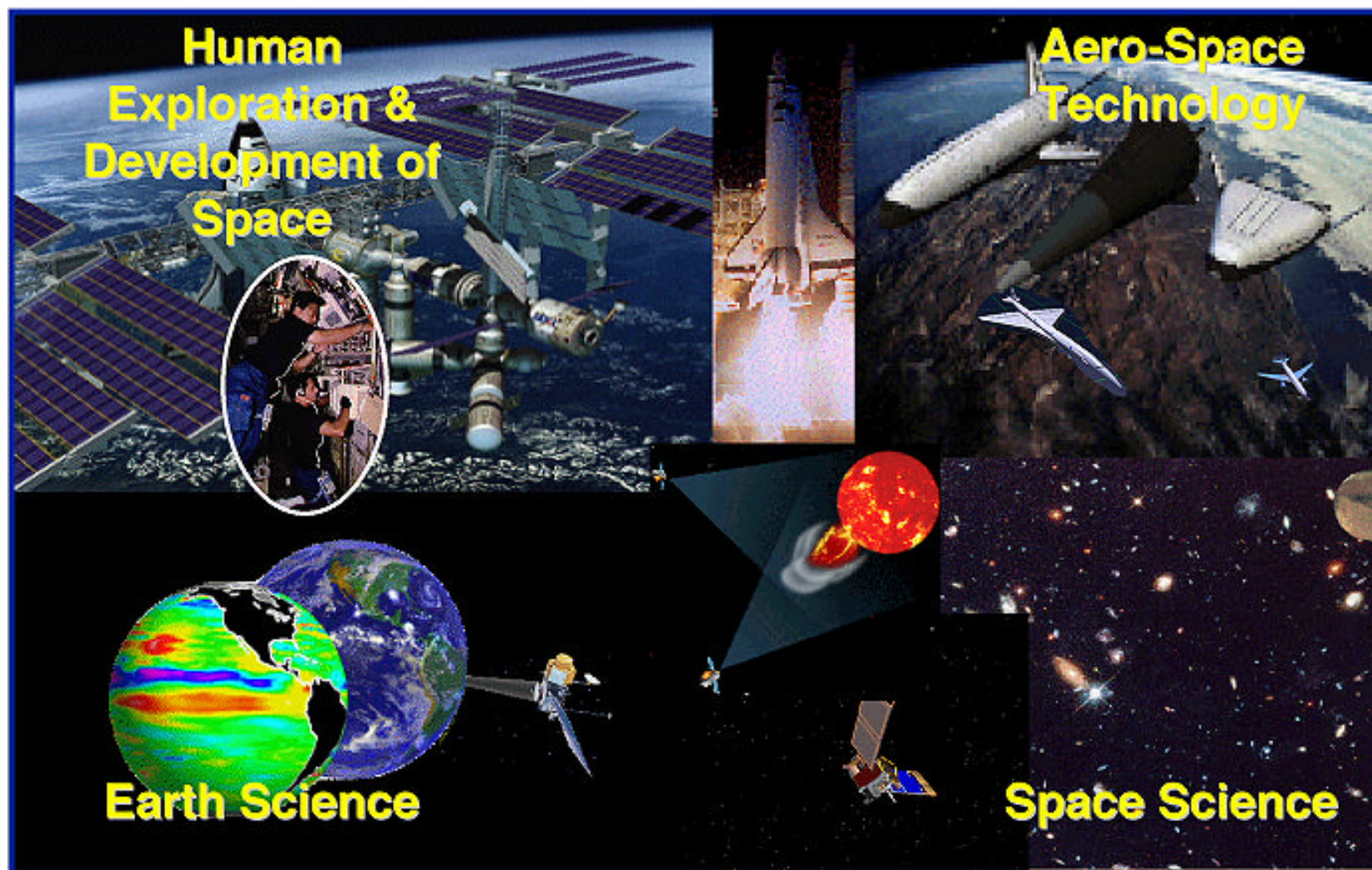






# A Functional Initiative Which Supports All NASA Strategic Initiatives

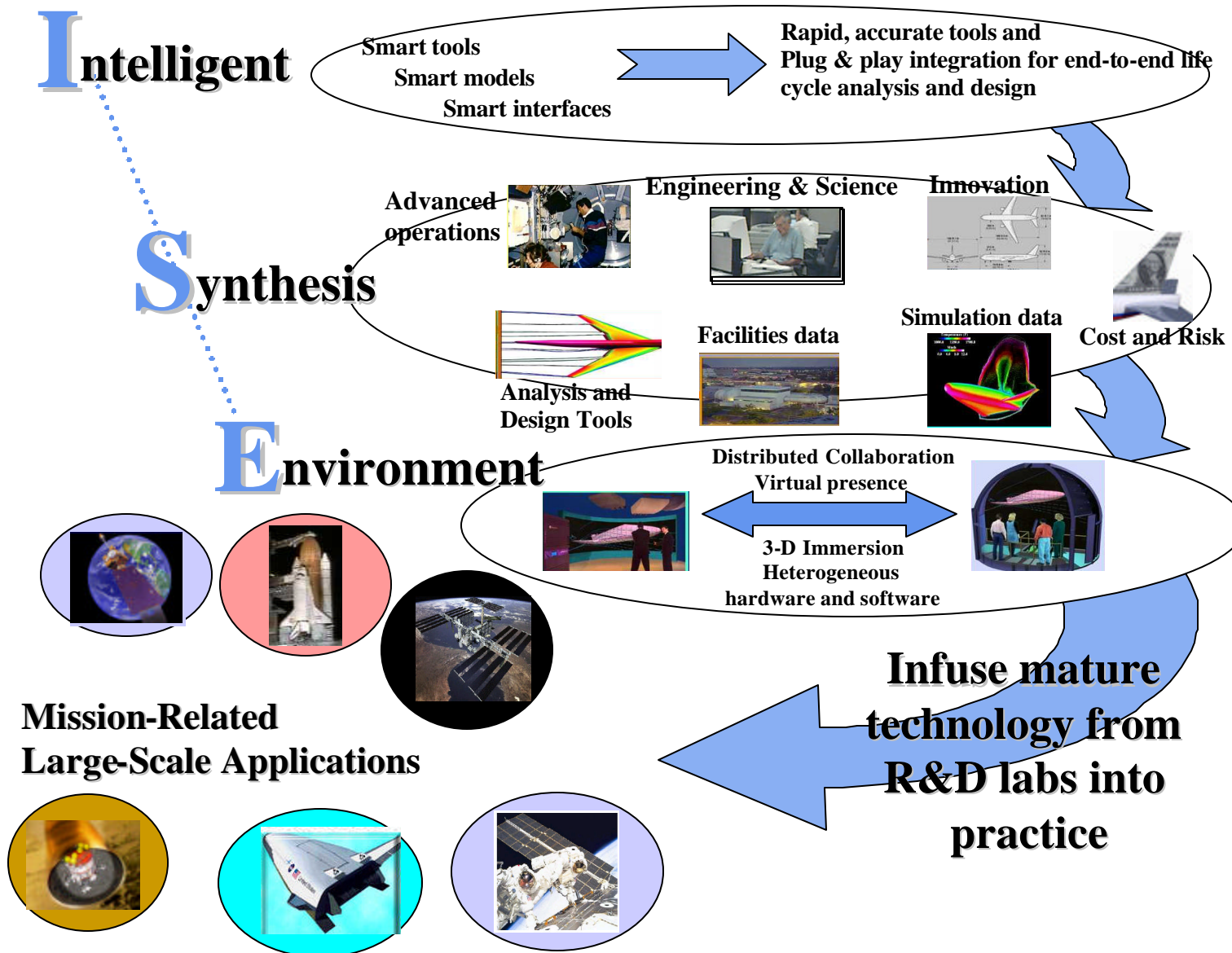
*Intelligent Synthesis Environment*





# ISE Initiative Formulated to Achieve Administrator's Vision

*Intelligent Synthesis Environment Industry/Academia Workshop*

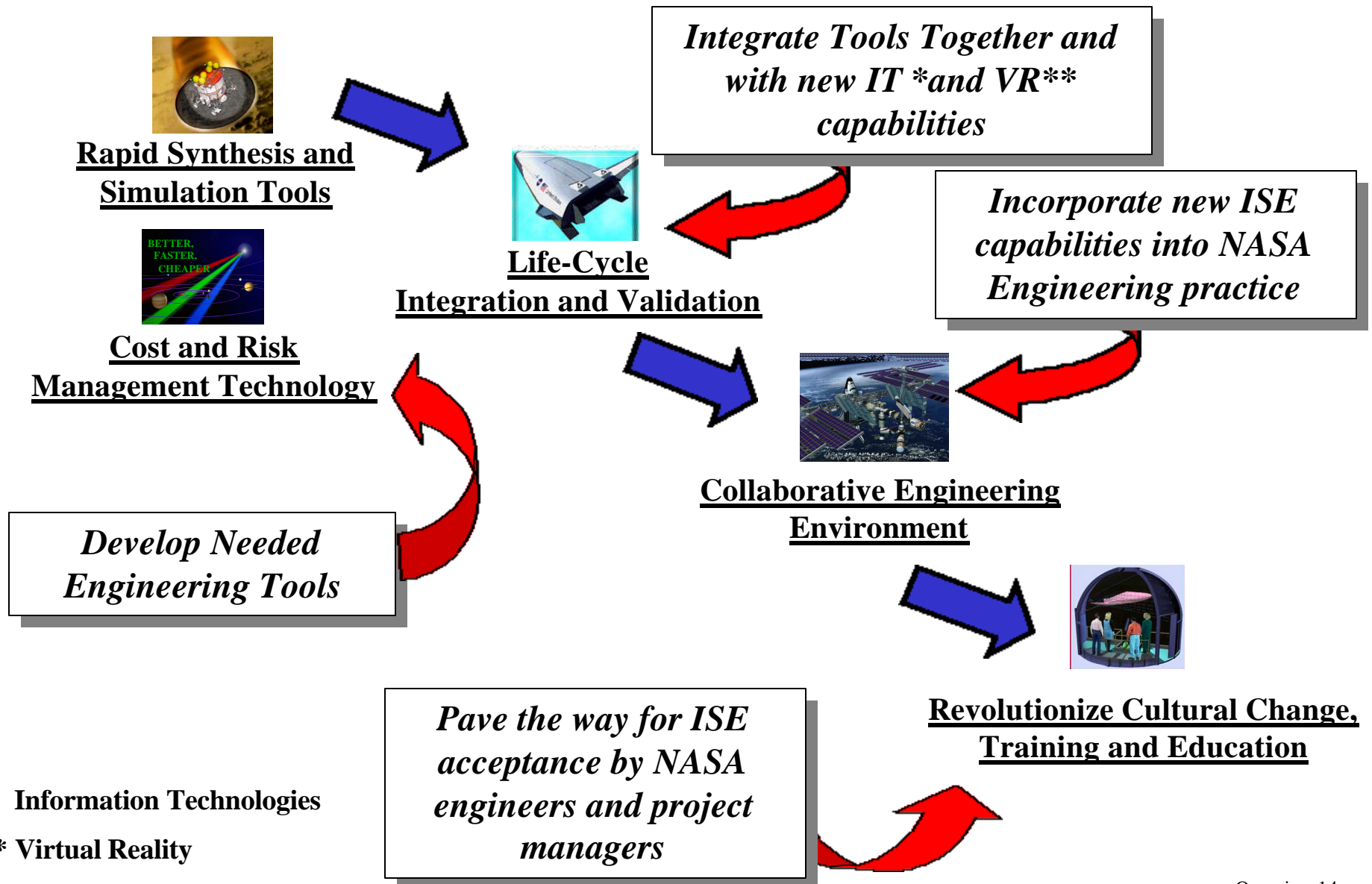






# Elements of the ISE Functional Initiative

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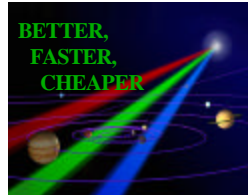
# Elements of the ISE Functional Initiative

## *Intelligent Synthesis Environment Industry/Academia Workshop*



### **Rapid Synthesis and Simulation Tools**

Developing advanced intelligence-based engineering and science simulation tools for analysis and design from concept through disposal and synthesis tools for seamless coupling of diverse discipline tools



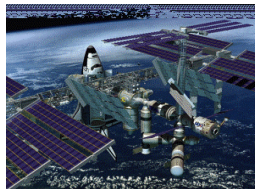
### **Cost and Risk Management Technology**

Develop advanced cost analysis and risk tools in a unified framework covering end-to-end mission design, and compatible with design and analysis tools for fully integrated life cycle simulations.



### **Life-Cycle Integration and Validation**

Developing integration methods, smart interfaces and frameworks to achieve seamless “plug and play” integrated design and analysis, and assessment, validation and demonstration of ISE technologies.



### **Collaborative Engineering Environment**

Advancing the state of practice and inserting the state of the art collaborative infrastructure and applied design and analysis capabilities into enterprise use.



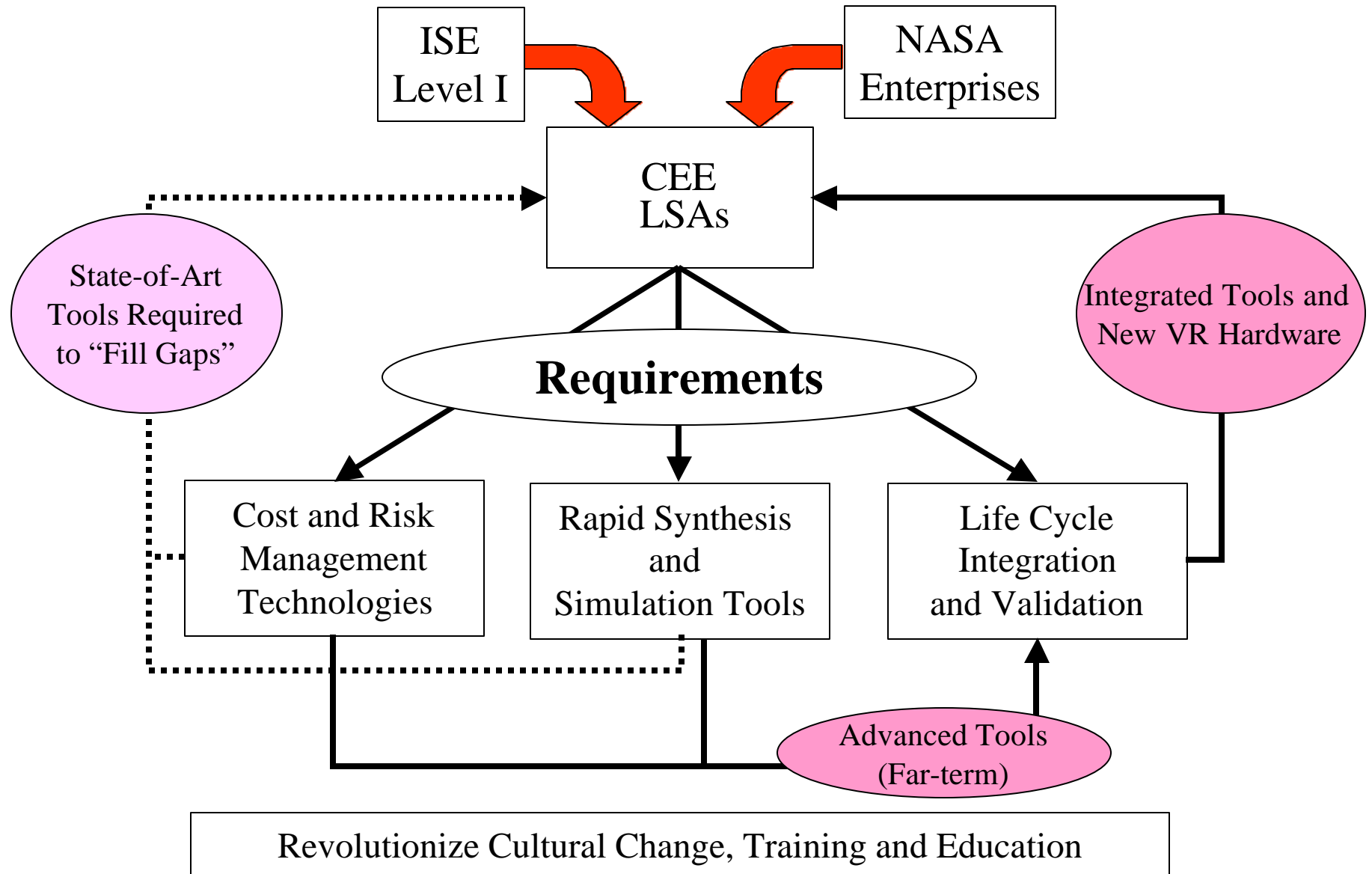
### **Revolutionize Cultural Change, Training and Education**

Changing the engineering culture to take full advantage of advanced tools and environments and developing distributed active learning and training collaborative environment



# ISE Planning Requirements Flow

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# Large-Scale Applications (LSAs)

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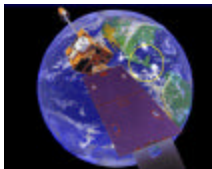
**Reusable Space Transportation Systems**



**Shuttle/International Space Station**



**Integrated Exploration and Science**



**Advanced Earth Observation**

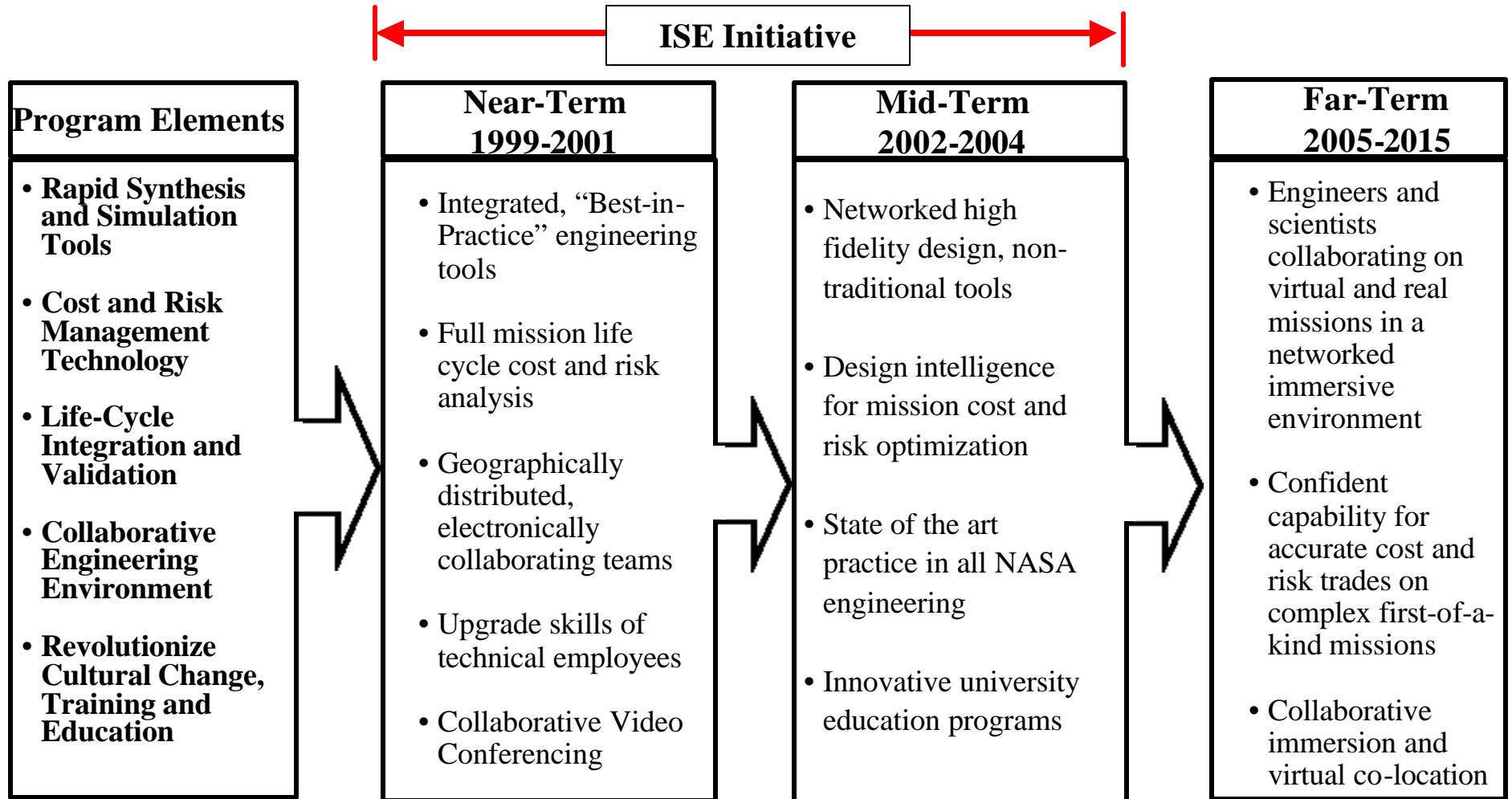
- *Tightly couples NASA R&D Center research products to Development Centers Needs*
- *An integration of computer hardware, software and facilities that enables the development of a design/analysis capability focused on specific mission needs*



# ISE Far-Term Program Roadmap

*Intelligent Synthesis Environment Industry/Academia Workshop*

*Vision: To effect a cultural change that integrates widely-distributed science, technology and engineering teams to rapidly create innovative, affordable products.*







# ISE Customers

## *Intelligent Synthesis Environment Industry/Academia Workshop*

- **The NASA Administrator wants ISE to provide the engineering environment, tools, and related capabilities NASA needs to accomplish its future missions**
  - **Primary** customer for ISE **is** NASA
  - Foremost needs/requirements are identified by ISE Large-Scale Application (LSA) Testbeds
- **The ISE plan will attempt to satisfy both NASA and its customers requirements**
  - ISE will be planned with customer participation and technical input
  - External customer advisory group will be formed
- **Potential external customers/partners**
  - Other Government Agencies
  - Aerospace industry *and* Non-aerospace industry
  - Hardware/software vendors
  - Engineering software vendors
  - Universities



# What ISE Is and Is Not

## *Intelligent Synthesis Environment Industry/Academia Workshop*

- ISE is about mainstream Computational Life-Cycle Simulations, and will not be directly involved with (i.e. will not fund):
  - Discipline technology developments (e.g. new material concepts, etc.)
  - Physical experiments or component testing (e.g. wind tunnel testing, etc.)
  - Physical mock-ups of technology concepts (e.g. configuration mockups, etc.)
  - Sensor and other test measurement device development
  - Computational work not directly in mainstream of ISE or LSA's



## What ISE Is and Is Not (cont'd)

### *Intelligent Synthesis Environment Industry/Academia Workshop*

- ISE does not intend to pick-up funding responsibility for most on-going computational efforts within current NASA programs, but does intend to fund new methods which hold promise of eventually achieving ISE goals
  - On-going programs should continue to support computational efforts that are deemed important to their goals/objectives
  - It is hoped that some on-going programs will choose to redirect appropriate activities to reflect ISE goals



# What ISE Is and Is Not (cont'd)

## *Intelligent Synthesis Environment Industry/Academia Workshop*

- **Requires the successful development of many technologies not directly funded by ISE, for example:**
  - advanced computing architectures
  - human-centered interactions
  - advanced, high-speed networking
  - secure networking and databases
  - experimental and test data for software validation, including simulation data and multidisciplinary data
- **Therefore .... ISE will attempt to leverage on-going research in NASA and OGA programs**
  - There is currently ~ \$200M in on-going OGA programs in related areas
  - Where possible, ISE will form co-operative activities with other NASA Programs such as Intelligent Systems (IS), the OA-ST Base Programs, HPCC, etc.
  - Where possible, ISE will form co-operative activities with US Government Agencies who have mutual interests in the simulation arena



# ISE Sets Challenging Stretch Goals

## *Intelligent Synthesis Environment Industry/Academia Workshop*

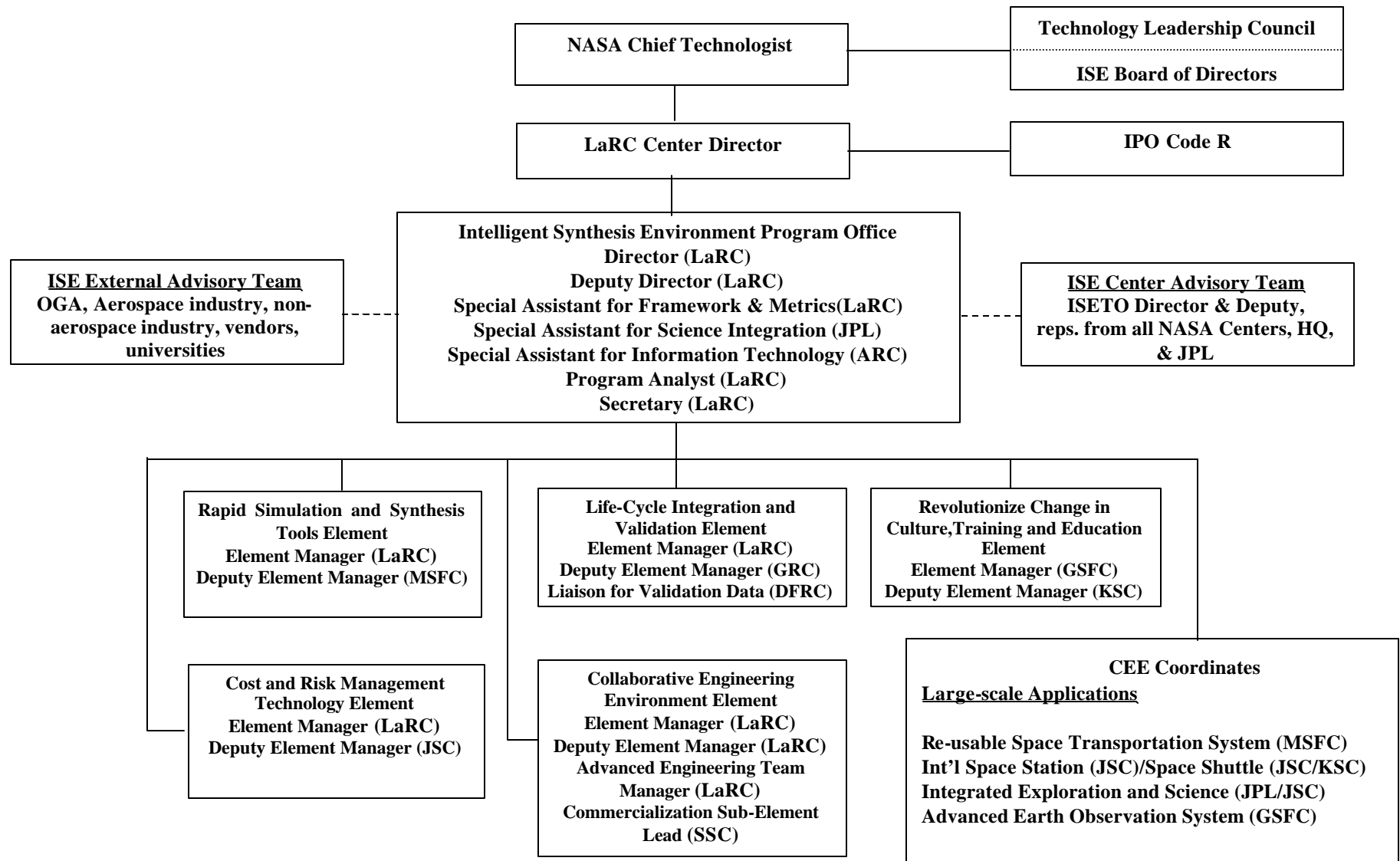
- **The attainment of ISE requires many significant advances in simulation capabilities - a few are:**
  - Simulation of complete life-cycle for different candidate engineering solutions
  - Variable modeling complexity requirements for conceptual, preliminary, detailed design phases
  - Integrated simulations of Fabrication, Manufacturing, Repair, Maintenance, and Operations together with physics-based analysis/design methods
  - Elimination of time-consuming, human-in-the-loop surface and volumetric gridding requirements for certain methods
  - Orders of magnitude increases in computational speeds
  - Total integration of different discipline modeling methods
  - Practical “software Intelligent Agents” to support human engineers/scientists
- **Requires people/organizations with similar vision and enthusiasm to accomplish its objectives**





# ISE - A Multi-Center Management Structure

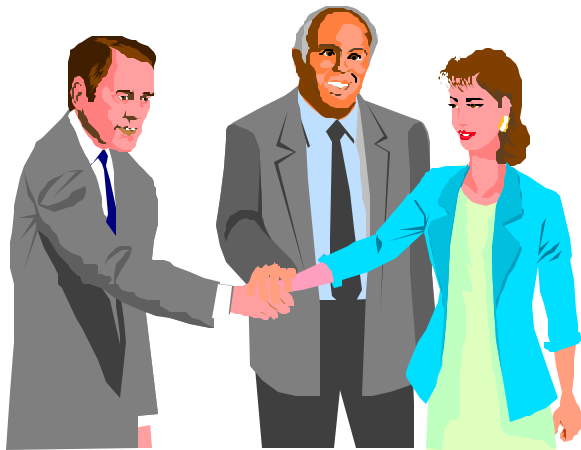
## *Intelligent Synthesis Environment Industry/Academia Workshop*



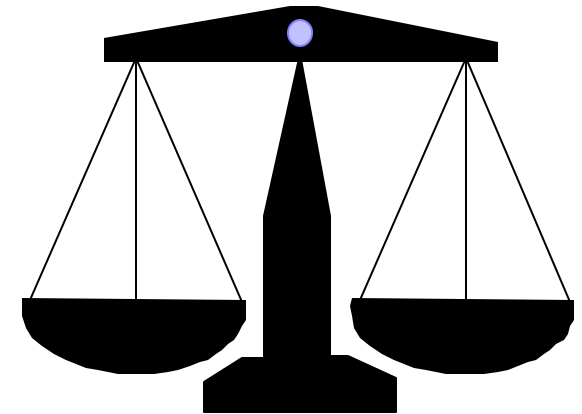
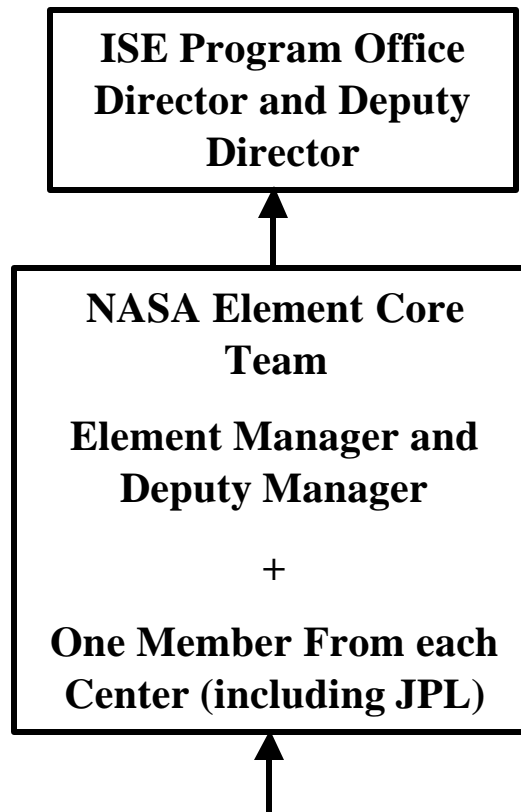


# ISE Planning and Product Teams

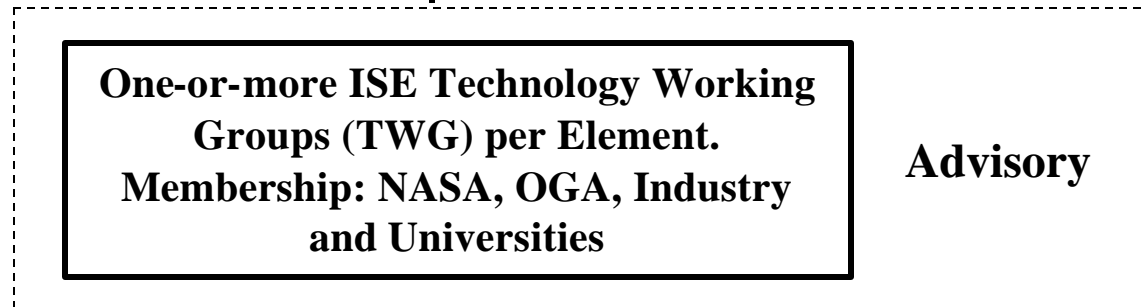
*Intelligent Synthesis Environment Industry/Academia Workshop*



**Technology Working Groups  
Strive for Consensus in  
Technical Plans, Funding  
Requirements,  
Lead/Participating Centers,  
Deliverables, etc.**



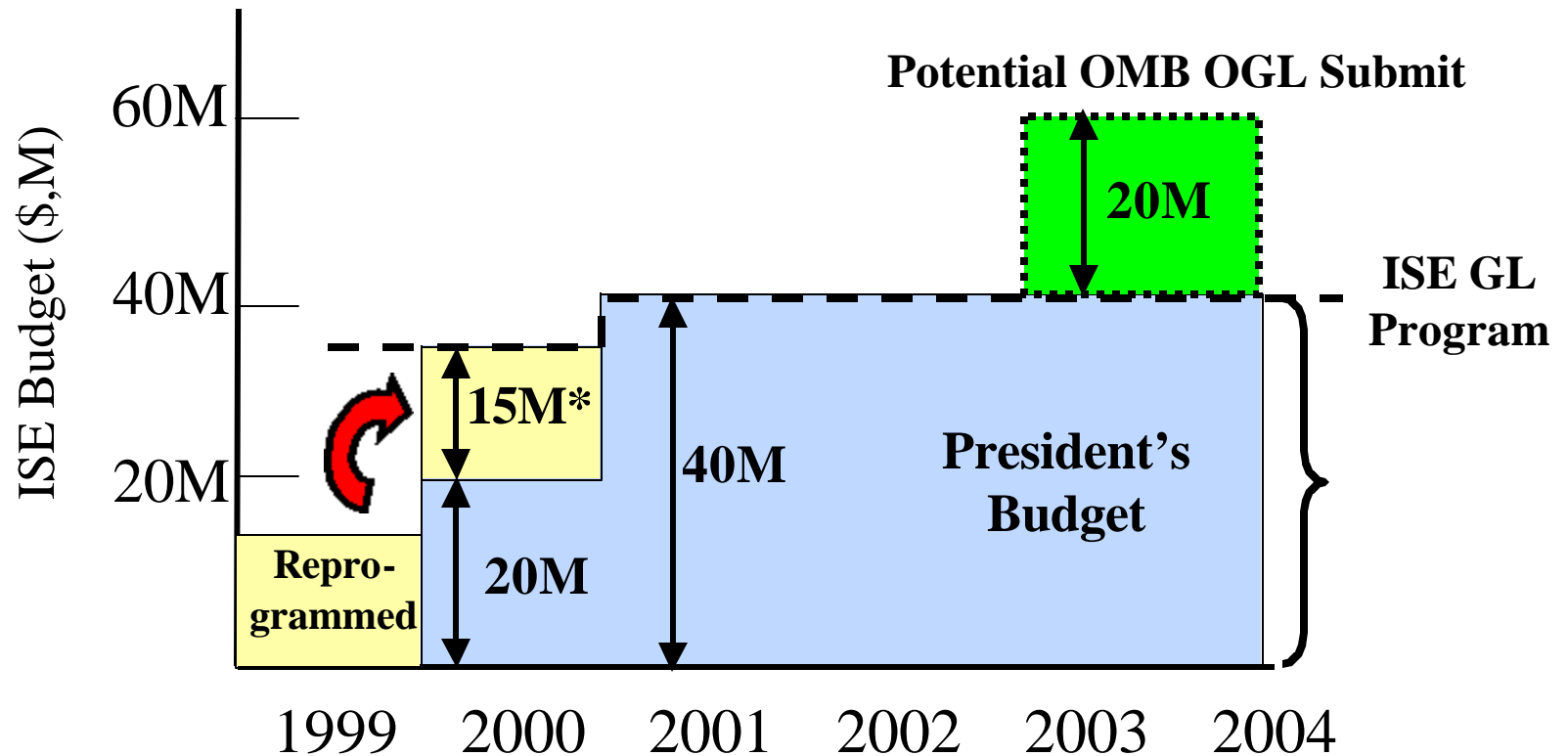
**Balanced Technical  
Program Element  
Plans**





# ISE Funding Profile

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\* Carryover of Reprogrammed FY99 \$'s for ISE



# ISE: A Challenging Stretch Goal for the 21st Century

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Successful development of the ISE Vision will require the combined efforts of NASA, Aerospace and Non-Aerospace Industry, Academia, and Professional Societies